This application was (originally) made under the Patent Cooperation Treaty with the Japanese Patent Office acting as the receiving office on 86 5 April 1979 being given an application number PCT JP 00087. The application was searched by the Japanese Patent Office acting as the International Search Authority (ISA) and published by the International Bureau on 87: 6 March 1980 under serial number WO 80/00316 in the Japanese language. The text of the application is contained in the publication made by the International Bureau as above identified, the accompanying text being an English translation thereof.

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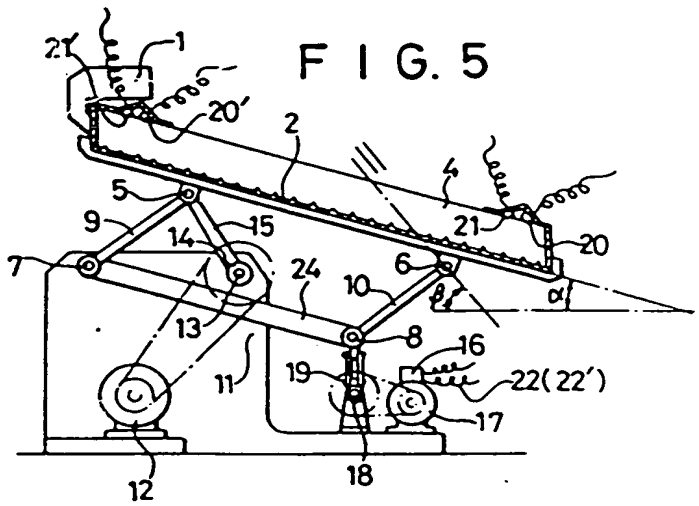
(54) Automatic control apparatus for oscillating-type grain sorting machine

(57) An automatic control apparatus for an oscillating-type grain sorting machine in which a grain sorting plate with a rugged surface oscillates in a direction of an angle of elevation for shaking up grains so that mixed grains are separated toward one side at front and/or rear of the sorting plate and flowed out sideways. A photoelectric device having in combination a photoreceptor element and a light source is provided at the position for detecting the flowing condition of the grains on the sorting plate. This photoelectric device detects the flowing condition of the grains on the sorting plate and thus automatically controls the angle of elevation, mean oscillating angle, and frequency or amplitude of the grain sorting plate so as to always keep the grain flow in its normal condition.

FIG. 5



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SPECIFICATION

Automatic control apparatus for an oscillating grain separator

TECHNICAL FIELD

This invention relates to an automatic control apparatus for an oscillating grain separator.

BACKGROUND ART

In the case of a grain separating operation using an oscillating grain separator provided with a grain separating plate having a rugged surface which is positioned horizontal in inclination with the angle of elevation and which oscillates at a mean oscillating angle that is larger than the angle of elevation to shake up grain and separate mixed grain toward one side of a grain separating plate at the front and rear thereof so that mixed grain is removed sideways, there is a nature wherein more grain on top of the grain separating plate gathers in a curved path toward the rear of the plate when the angle of elevation of the grain separating plate increases and more grain gathers in a curved path toward the front of the plate when the mean oscillating angle, frequency or amplitude increases and the grain separating operation is determined by the flow distribution of grain. Therefore, if there is a change in flow distribution, immediate adjustment of same to a normal flow rate is necessary. In the past, such adjustment was performed manually by adjusting the angle of elevation of the grain separating plate.

However, it is difficult to cope with and adjust the flow distribution of grain.

DISCLOSURE OF INVENTION

It is a primary object of the present invention to provide an automatic control apparatus of an oscillating grain separator which detects changes in light rays projected from a light source, caused by grain, by the amount of light received by a light receiving element thus emitting a signal to rotate a driving means in either a clockwise or counterclockwise direction, constantly adjusting factors such as angle of elevation, mean oscillating angle, frequency, amplitude and the like automatically to maintain a normal flow condition in order to obtain high accuracy in the grain separating operation.

In order to attain the above-mentioned object, this invention relates to an automatic control apparatus for an oscillating grain separator wherein a light source and a light receiving element are amounted in a detecting area to detect the flow condition of grain on the grain separating plate, gathering on at least either one of the front or rear grain separating plate frames comprising the grain separating plate provided with a rugged surface oscillating along in a direction horizontal to the angle of elevation of the surface and the side wall formed around the grain separating plate and wherein an electrical circuit of a driving means for adjusting the grain flow separating plate with a photoelectric means will have remarkable results in increasing the grain separating accuracy and rationalizing the operation through energy conservation.

Another object of this invention is to provide an automatic control apparatus of an oscillating grain separator having an area, for detecting grain flow conditions on the grain separating plate is located on the upper portion of the grain separating plate frame.

Still another object of this invention is to provide an automatic control apparatus of an oscillating grain separator wherein the detecting area for detecting grain flow condition on the grain separating plate is located on the upper and lower portion of the grain separating plate frame.

A further object of this invention is to provide an automatic control apparatus of an oscillating grain separator having the detecting area, for detecting grain flow conditions on the grain separating plate, located on the lower portion of the grain separating plate frame.

A still further object of this invention is to provide an automatic control apparatus of an oscillating grain separator wherein the detecting area, for detecting grain flow conditions on said grain separating plate, located on the side portion of the side wall in the grain separating plate frame.

A still further object of this invention is to provide an automatic control apparatus of an oscillating grain separator wherein the area, for checking grain flow condition on said grain separating plate, located on the lower part of said side wall in said grain separating plate frame and the upper part of said grain separating plate.

A still further object of this invention is to provide an automatic control apparatus of an oscillating grain separator wherein the driving means, for adjusting grain flow conditions, is a controlling motor which rotates around a threaded shaft threadably engaged to an adjusting lever which rotates around a rotary lever of the grain separating plate frame.

A still further object of this invention is to provide an automatic control apparatus of an oscillating grain separator wherein the rotary lever is bridged across the standing frame at a common point where the oscillating lever supports the grain separating plate frame and wherein an eccentric means is connected to the oscillating lever.

A still further object of this invention is to provide an automatic control apparatus of an oscillating grain separator wherein the rotary lever is bridged across the standing frame between the front and rear oscillating levers each of which supports the grain separating plate frame and wherein the eccentric means is connected to the oscillating lever.

A still further object of this invention is to provide an automatic control apparatus of an oscillating grain separator wherein the driving

Figs. 1 and 2 are a plan view and vertical-sectional view, respectively, of the principal parts of an embodiment according to the present invention;

Figs. 3 and 4 are vertical-sectional view and plan view, respectively, of principal parts which are different from those in Fig. 1 and Fig 2;

Fig. 5 is a vertical-sectional view of first embodiment according to the present invention;

Fig. 6 is a front view of the first embodiment;

Fig. 7 is a vertical-sectional view of a second embodiment according to the present invention;

Fig. 8 is a front view of the second embodiment;

Fig. 9 is a vertical-sectional view of a third embodiment according to the present invention;

Fig. 10 is a vertical-sectional view of the principal parts of fourth embodiment according to the present invention;

Fig. 11 is a vertical-sectional view of the principal parts of a fifth embodiment according to the present invention;

Fig. 12 is a vertical-sectional view of the principal parts of a sixth embodiment according to the present invention;

Fig. 13 is a vertical-sectional view of the principal parts of a seventh embodiment according to the present invention; and

Fig. 14 is an electric circuit of the apparatus according to the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

The relations between flowing phenomena of grain, such as unhulled rice, incompletely hulled rice and hulled rice on the grain separating plate and a photoelectric means thereof are illustrated in the accompanying drawings. Figs. 1 and 3 show the flowing phenomena of the flow of unhulled, incompletely hulled and hulled rice on the grain separating plate respectively and Figs. 2 and 4 show vertical sectional views thereof.

In Figs. 1 and 2, when the flow of hulled rice is led out toward the front area forming a curved path, the rear area of a grain separating plate 2 is exposed and a reflected ray caused by light source 20 which projects a light ray onto the grain separating plate 2 is received and detected by light receiving element 21 and the output signal of the light receiving element 21 is set to a driving means (not shown) to adjust the flow of the grain so that exposed area of the grain separating plate 2 will be covered with unhulled rice.

The overall structure of the first embodiment for performing the above-mentioned operation is explained hereafter.

In Figs. 5, 6, in the lower part of the hopper 1 into which the grain are supplied, a grain separating plate frame 4 comprising a rugged surfaced grain separating plate 2 and side walls 3 constructed around the grain separating plate 2 is lower joint 7 of rotary lever 24 is pivoted in a frame 11.

An eccentric cam 14 connected to a main shaft 13 which is driven by main motor 12 and upper joint 5 is connected by means of a rod 15 and the grain separating frame 4 is oscillated back and fourth at an oblique forwardly elevated oscillating angle β. Upper area of both adjusting levers 19 are threadably engaged at lower portions thereof with a threaded rod 18 which is driven clockwise and counterclockwise, respectively, by a control motor 17 provided with a control driving means 16 the upper area of which is connected to the area near the lower joint 8 of the rotary lever 24 and both adjusting levers 19 on the threaded rod 18 are caused to approach and part from each other. Thus rotary lever 24 is rotated around the lower joint 7 to adjust the height of upper point 6 and thus the angle of elevation α of the grain separating plate 2 is adjusted.

At one side the upper rear area of the grain separating plate frame 4 of the grain separating plate 2, a light source 20 and a light receiving element 21 which projects the light to the grain separating plate 2 are positioned at such an angle so as to reflect and receive the light, respectively, at the upper front area of one side of the grain separating plate frame 4 of the grain separating plate 2, the light source 20 and the light receiving element 21 being erected in the same manner as mentioned above and light receiving elements 21, 21' and a control apparatus 16 of the drive means are connected to an electric circuit 22.

Mixed grain of hulled and unhulled rice supplied from the hopper 1 to the grain separating plate 2 are shaken up toward the front portion thereof by oscillating approach and parting operation of the angle β wherein unhulled rice grain of smaller specific gravity and of large coefficient of friction float upward over the hulled rice grain which have larger specific gravity and less coefficient of friction and which flow toward the rear in a curve and thus, hulled and unhulled rice grain are separated to each side of the rear and front of the grain separating plate 2 and led out toward the end of a side 23.

The flow of either hulled or unhulled rice flows in a curve to the front or rear of the grain separating plate 2 as mentioned above and when the exposed area appears and actinates the driving means which is connected to the photo-electric means, the flow of grain is automatically adjusted to perform a stable and highly accurate grain separating operation.

Furthermore, using the amount of reflected light sensitive to hue difference of grain various kinds of grain can be detected. Therefore, using a specific mixture rate of the mixed grain flow distribution of the grain particles can be adjusted. A filter may be used for detecting hue difference of grain.

The operation of the second

shaft 13 with an end thereof pivoted toward a lower point 8 connected to an adjusting lever 19.

By the clockwise or counterclockwise rotation of a control motor 17 of the drive means across a threaded shaft 18 and the adjusting lever 19, the lower point 8 moves up and down to adjust the angle of inclination of the rotary lever 24 and the oscillating angle β of the grain separating plate 2 to perform a stable and highly accurate grain separating operation.

In Fig. 9, the construction of the third embodiment is shown, wherein an automatic control means 16 which is connected to light receiving elements 21, 21', and a variable speed means 25 and actuated by a main motor 12, a main shaft 13 being driven by the variable speed means 25.

The frequency of the grain separating plate 12 is controlled in order to automatically adjust the flow of hulled and unhulled rice on the grain separating plate 2, and a stable and highly accurate grain separating operation is performed.

Furthermore, a condenser lens is provided in the light path between the light source 20 and the light receiving element 21 to vary the amount of light received by the light receiving element 21 by increasing or decreasing the distance from the light source to the projected bodies for example the height of the grain, that is, the height of a layer of grain actuates the operation of the driving means for adjusting the flow conditions of the grain.

Fig. 10 shows a fourth embodiment wherein at one front side and at one rear side of the grain separating plate 2, transparent windows 26 are provided, respectively, a downwardly facing light source 20 which projects light to a light receiving element 21 is provided above the grain separating plate 2 with its light receiving element 21 facing upwardly to detect the presence or thickness of the grain layer by status of the light ray which either passes or becomes intercepted or varies depending on the layer condition.

Fig. 11 shows a fifth embodiment wherein at one front side and one rear side of the grain separating plate 2 there are provided transparent windows 26, respectively, under each of which there are provided a light source 20 and a light receiving element 21 and by the reflected ray, light receiving element 21 detects the grain particles on the grain separating plate 2.

Fig. 12 shows a sixth embodiment wherein at one front side and one rear side of the grain separating plate 2, there is a transparent windows 26 on the side-wall 3 provided with a light source 20 and a light receiving element 21 and when the layers of unhulled rice are particularly thick, its top most layer is checked to adjust the excess flow of grain.

Fig. 13 shows a seventh embodiment wherein thickness of the unhulled rice layer flowing 21 is located at the lower area of the side-wall 3 and the light source 20 which projects light to the light receiving element 21 is located at the upper area of the grain separating plate 2.

Due to the various thicknesses of the unhulled rice layer, the light ray is intercepted and in accordance with the interception, the unhulled rice is checked.

In another words, this invention checks, by transmitting light to the light receiving element from a light source either with direct reflected light rays from the light source or projected light of the light-reflected ray.

Next, Fig. 14 shows the electric circuit of the embodiment concerning a photoelectric apparatus. Light sources 20, 20' and light receiving elements 21, 21' are connected to the driving means comprising an automatic control device 16 and a control motor 17. Light rays projected from electric lamps 27, 27' for the light source is received by photodiodes 28, 28' of the light receiving element 21, 21' and the generated voltage is amplified and the automatic control device 16 operates the variable resistors 30, 30' which determine their points of operation according to the amount of light.

In order to make the control motor 17 rotate clockwise or counterclockwise, the control device 16 including light receiving elements 21, 21', voltage amplifiers 29, 29' variable resistors 30, 30' and relays 31, 31', and a pair of electric circuit 22, 22' are connected to a control motor 17.

The electric circuit of the drive means used in this invention is an electric circuit which rotates the motor clockwise or counterclockwise and is an electromagnetic-type electric circuit which operates a clutch that in turn operates a transmission clockwise and counterclockwise. The transmission is driven by the motor which rotates in either direction.

The light source of the photoelectric apparatus in this invention means an electric lamp such as an incandescent lamp, an arc lamp, a fluorescent lamp, or a luminous diode.

The photoelectric converting element, in other words, a light receiving element, means a photo-electrotransducer element such as a selenium cell, a silicon solar cell, a photodiode, a phototransistor, or a photo-electric discharging element such as a photoelectric tube, a photomultiplier, a television camera tube, or an image tube.

A photoelectric converting element may also be located at either both front and rear portions of the grain separating plate or at either one of the sides of the grain separating plate.

CLAIMS

1. An automatic control apparatus of an oscillating grain separator comprising a light source and a light receiving element mounted in a

grain separating plate to collect said grain, said grain separating plate is provided with rugged surface, which oscillates along in the horizontal direction to the angle of elevation of the surface of said plate, and has side walls thereround, and further comprises an electrical circuit of a driving means for adjusting the flow conditions of said grain which is connected to an electrical circuit of said light receiving element.

2. An automatic control apparatus as claimed in Claim 1, wherein the detecting area for detecting the flow conditions of the grain on said grain separating plate is positioned in the upper portion of said grain separating plate frame.

3. An automatic control apparatus as claimed in Claim 1, wherein the detecting area for detecting the flow conditions of grain on said grain separating plate is positioned in the upper and lower portion of said grain separating plate frame respectively.

4. An automatic control apparatus as claimed in Claim 1, wherein the detecting area for detecting the flow conditions of grain on said grain separating plate is positioned in the lower portion of said grain separating plate frame.

5. An automatic control apparatus as claimed in Claim 1, wherein the detecting area for detecting the flow conditions of grain on said grain separating plate is positioned in the side wall portion of said grain separating plate frame.

6. An automatic control apparatus as claimed in Claim 1, wherein the ares for checking the flow conditions of grain on said grain separating plate are positioned at the lower portion of said side walls of said grain separating plate, respectively.

7. An automatic control apparatus as claimed in anyone of claims 1 to 6, wherein said driving means for adjusting the flow conditions of grain is a control motor which rotates around a threaded shaft threadedly engaged to an adjusting lever which swings around a rotary lever of said grain separating plate frame.

8. An automatic control apparatus as claimed in Claim 7, wherein said rotary lever is bridged across a standing frame at a common point where oscillating levers support said grain separating plate frame and eccentric cams are connected to said oscillating levers, respectively.

9. An automatic control apparatus as claimed in Claim 7, wherein said rotary lever is bridged across said standing frame between said oscillating levers which support said grain separating plate frame and an eccentric cams are connected to said oscillating levers respectively.

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FIG. 1

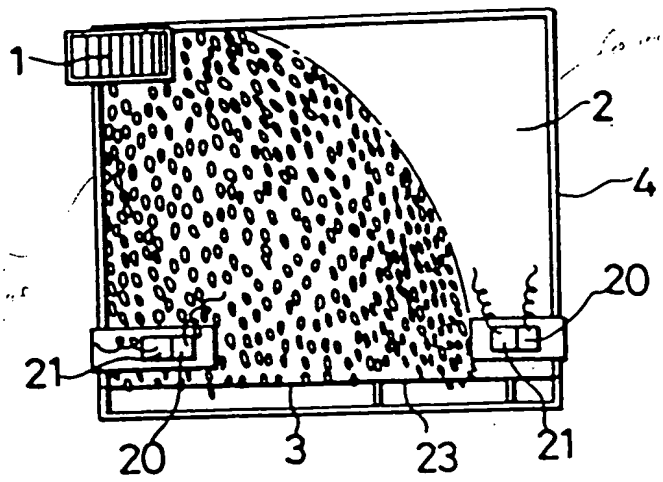


FIG. 2

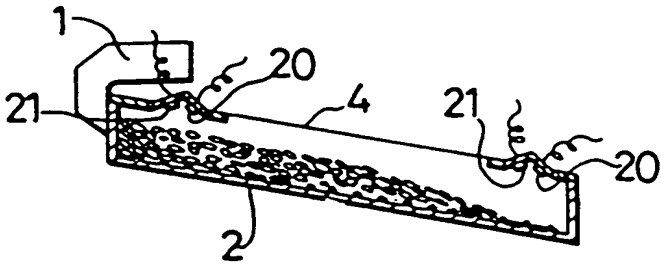


FIG. 3

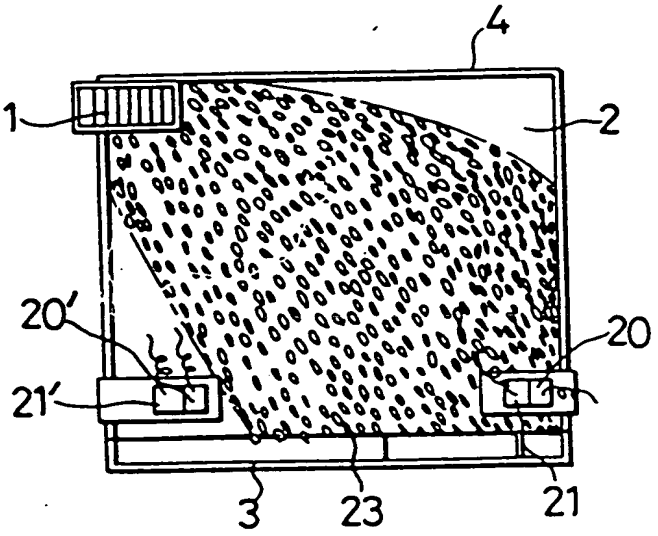


FIG. 4

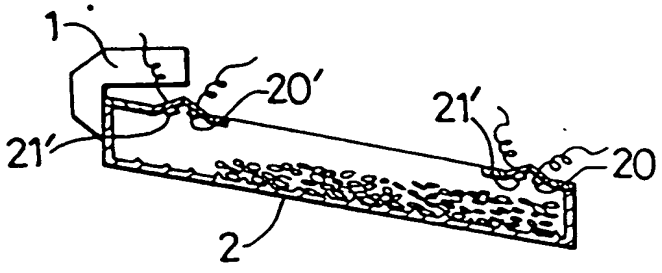


FIG. 5

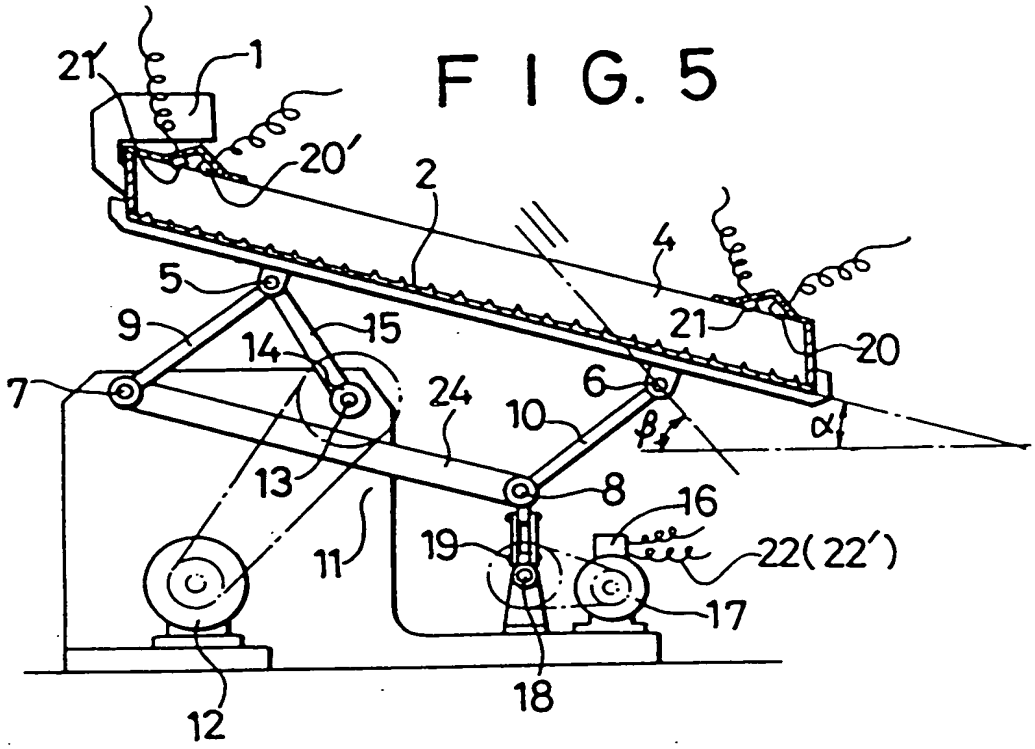
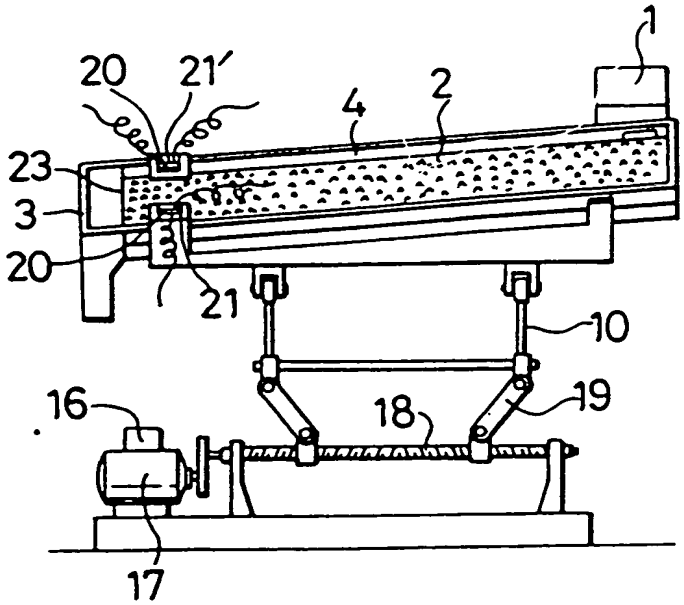

21'
1
20'
2
4
5
9
14
15
21
20
7
24
6
10
β_1
α_1
13
8
16
11
19
22(22')
17
12
18

FIG. 6


1
20
21'
4
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20
21
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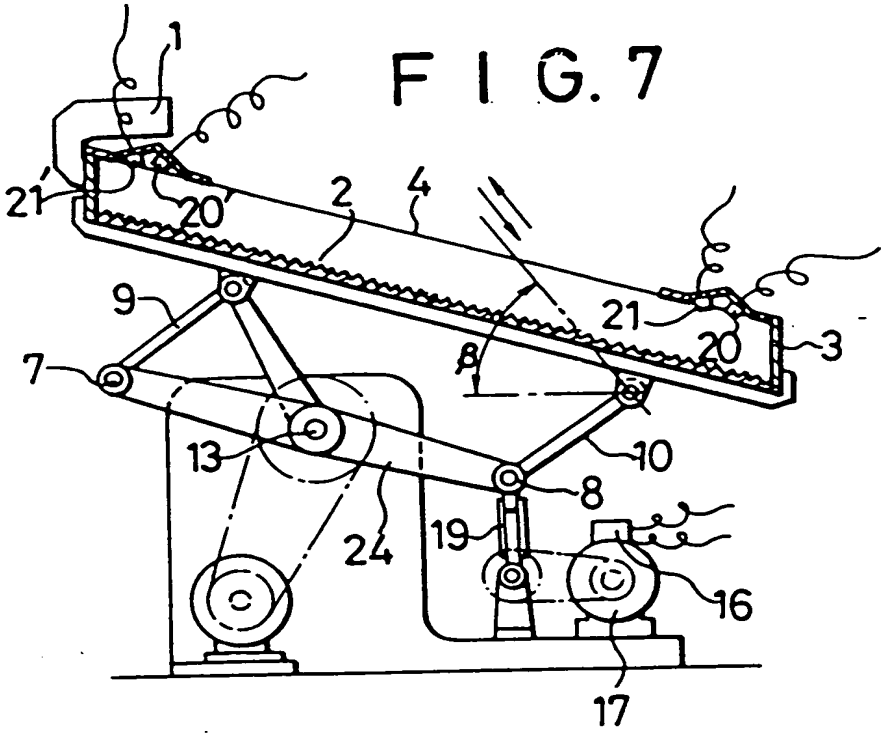
16
18
19
17

FIG. 7


1
21'
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β
13
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19
16
17

FIG. 8

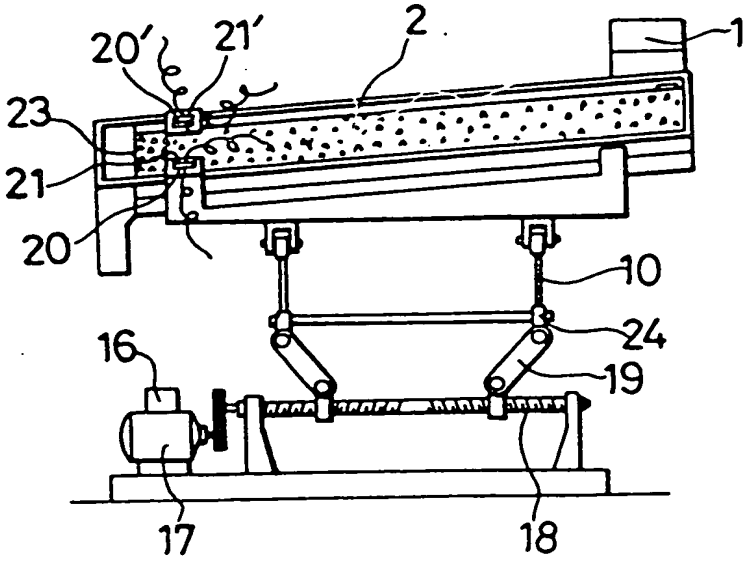
20'
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FIG. 9

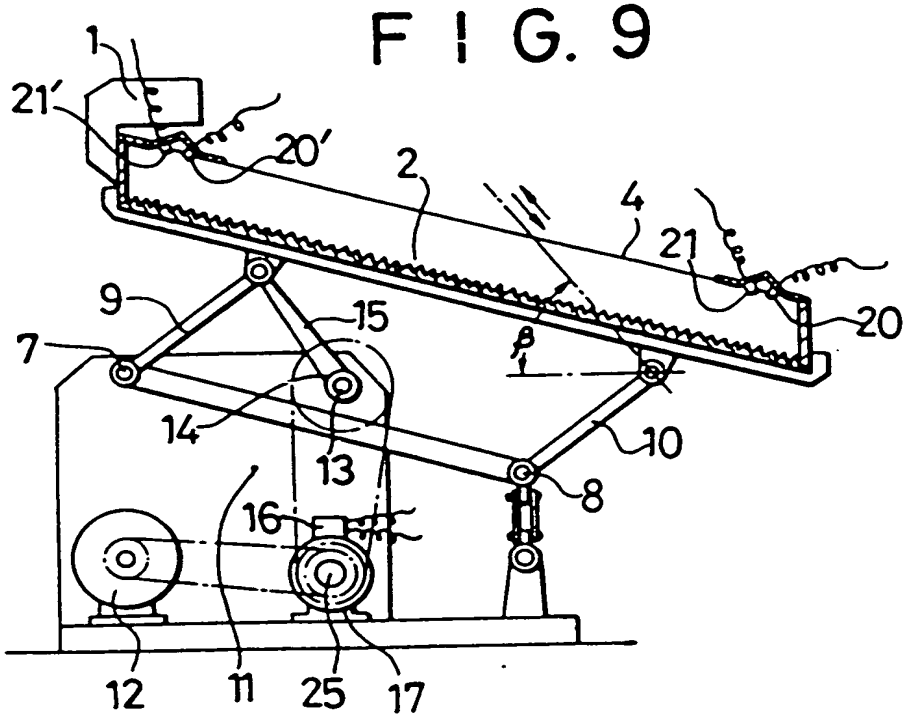

FIG. 10

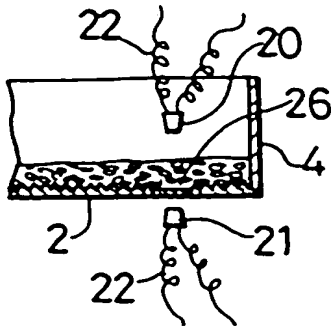

FIG. 11

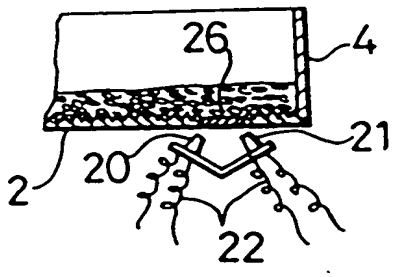

FIG. 12

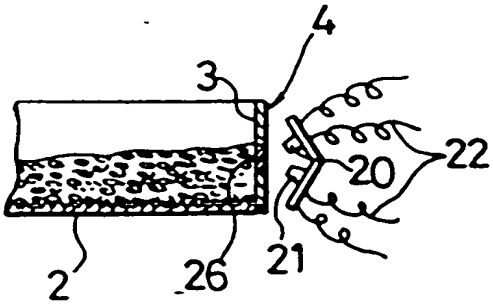

FIG. 13

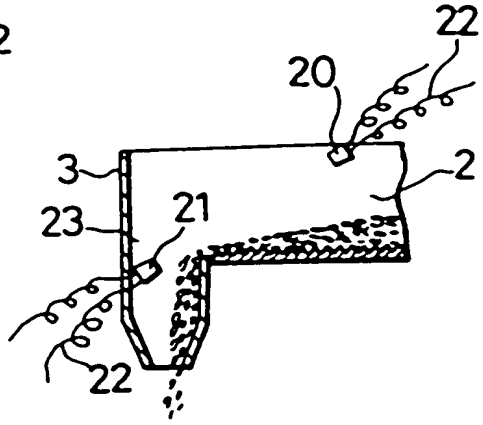

FIG. 14